

MORGULIS, N. D.

Three-Electrode Spherical Discharge. (In Russian)  
N. D. Morgulis. *Journal of Technical Physics* (U.S.S.R.), v. 17, no. 2, 1947, p. 263-268.

Describes a newly developed three-electrode spherical discharger for the measurement of very high voltages. Test results indicate that such a discharger may have wide practical application.

MISC. TUBES

MORGULIS, N. D.

PAZOT90

USSR/Physics

Sep 1947

Electrons - Emission  
Cathodes - Emission

"Auto-electronic Emission of Complex Semiconducting Cathodes," N. D. Morgulis, 4 pp

"Zhur Tekh Fiz" Vol XVII, No 2 pp. 943-6  
Izv. Akad. Nauk SSSR, Kiev

Examination of the properties of an electronic emission from present-day complex semiconducting cathodes. For the case of a small internal electric field with an intensity of  $E \lesssim 5 \cdot 10^5 \text{ V/cm}$ , a formula is deduced for an auto-electronic current from the semiconductors, which is essentially distinguished from the known formula of Fowler and Nordheim for metals.

40790

MOROUKIS, H.D. [reviewer]; VLASOV, V.F. [author].

"Electron tube apparatuses." V.F. Vlasov. Reviewed by H.D. Morgulis.  
Usp. fiz. nauk 31 no.1:153-154 '47. (MLRA 6:12)  
(Electron tubes)

MORGULIS, H.D. [reviewer].

"Applied electronics." Electr. Eng. Staff of the M.I.F. Wiley and  
Sons. N.J. 1945. Reviewed by H.D. Morgulis. Usp. fiz. nauk 31 no.1:  
154-155 '47. (MLBA 6:12)  
(Electronics)

MOGULIS, R. D.

"A Review of 'Electronic Equipment' by E. Bruche and A. Recknagel," Uspekhi  
Fiz. Nauk, 32, No 1, 1947.

Mar 1947

USSR/Electronics  
Impulses, Electric  
Sound

"A. A. Kapitov's Book, 'Electrical Phenomena in  
Gases and Vacuums,' N. D. Murgulis, 2 pp

"Dopelhi Fiz Nauk" Vol XXXIII, No 3

Reviews 808-page book published, 1947, in Leningrad  
by Gosftekhn Publishing House. States that release  
of book an event that should be hailed by all Soviet  
workers engaged in electronic physics, or in the  
transfer of electric impulses into sound. Third  
issue of series, and comparison of the three vol-  
umes tends to show the great progress of Soviet  
US

50722

Mar 1947

USSR/Electronics (Contd)

science in this field. States that book is a must  
for all young technicians as best method to learn  
of all contemporary techniques.

50722

PA 50722

MURGULIS, N.D.

MORGULIS, N. D.

PA 58T26

USSR/Electricity  
Cathodes, Oxide  
Atomization

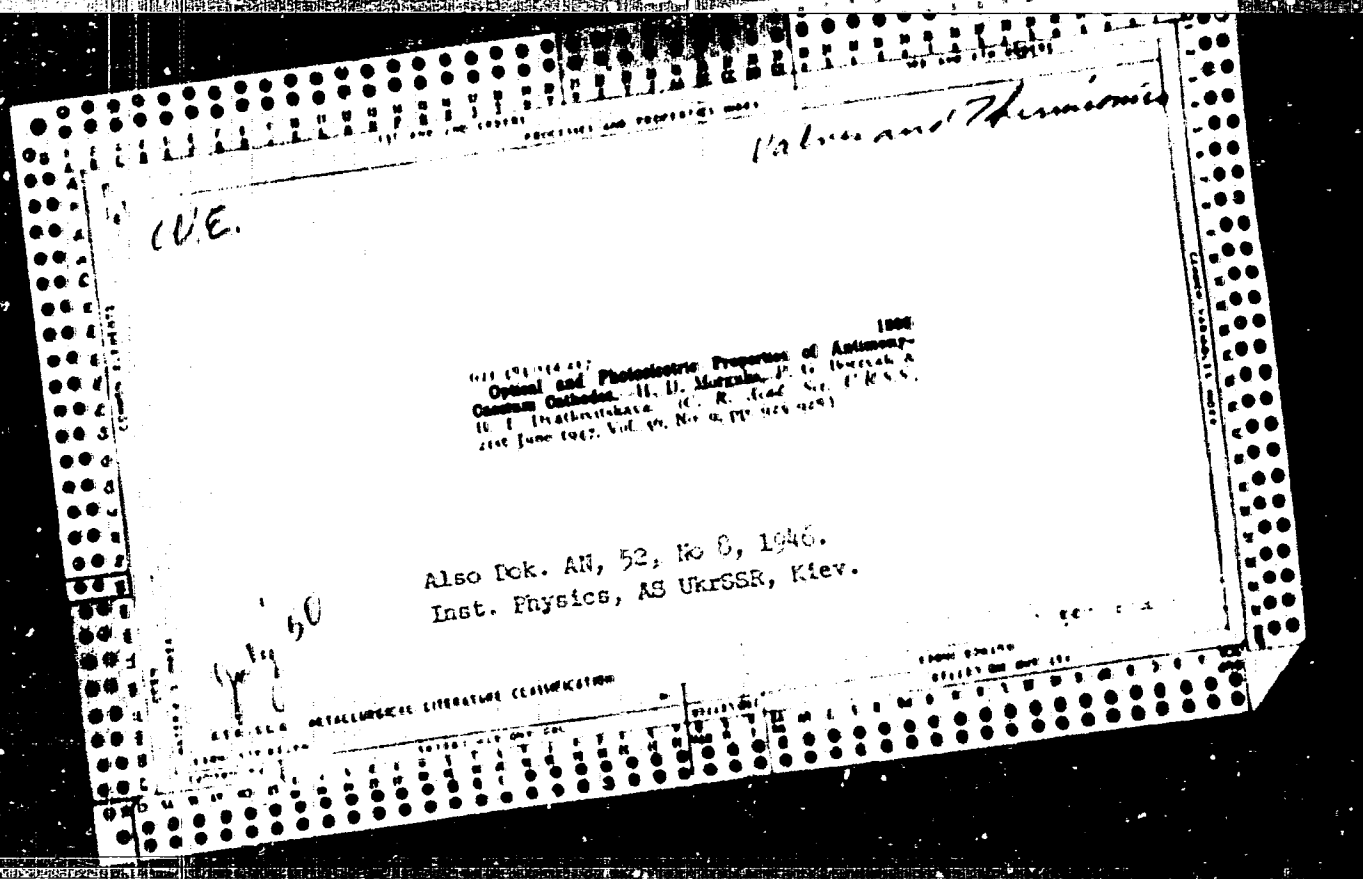
May 1947

"Atomization of Oxide Cathodes in Mercury Vapor Discharges," N. D. Morgulis, Ya. L. Lyubarskiy, Kiev State U, 4 pp

"Dok Akad Nauk SSSR, Nova Ser" Vol LVI, No 6

Describes experiments which establish existence of atomization of oxide cathode in a mercury discharge. Shows that effect may not be noticeable for a long time because of complete concealment of cathode generation which occurs at same time. Submitted by Academician S. I. Vavilov, 25 Dec 1946.

58T26





PA 6792

MORGULIS, N. D.

Mar/Apr 1948

USSR/Physics  
Optics  
Photoelectricity

"Optic and Photoelectric Properties of Antimony-Cesium Cathodes," N. D. Morgulis, P. G. Borsyak, B. I. Dyatlovitskaya, Inst Phys, Acad Sci USSR, 16 pp

"Iz Ak Nauk SSSR, Ser Fiz" Vol XII, No 2

Detailed account of recent research in this field accompanied by a sketch of apparatus and graphs showing experimental results. Discusses theory of subject. Authors consider that a substantial contribution has been made to existing knowledge and theoretical and practical investigations are being continued.

69792

MORGULIS, N. D.

Review of A. A. Ivanov's Book Electro-vacuum Technology, Uspekhi Fiz. Nauk  
35, No 1, 1948.

MORCULIS, F. D.

May 1948

USSR/Physics  
Ionization  
Cathodes

"The Problem of Ionization of Atoms and Neutralization of Ions on the Surface of a Hemiconductor Cathode," F. D. Morgulis, Inst of Phys, Acad Sci Ukrainian SSR, Kiev, 6 pp

"Zhur Teth Fiziki" Vol IVIII, No 5-17. 567-72

Phenomena are described and distinguished from those associated with metallic surfaces. Approximate probability expressions are deduced by means of which it is possible to explain results obtained in pre-

757100

May 1948

USSR/Physics (Contd.)

vious investigations of calcium and magnesium oxides Submitted 16 Dec 1947.

PA 757100

757100

MORGULIS, N. D.

Review of S. Yu Luk'yanov's Book Photoelements, Uspekhi Fiz. Nauk 35, No 3, 1948.

MORGULIS, N. D.

Review of S. Inanananda's Book, High Vacua', Uspekhi Fiz. Nauk 36, No 1, 1948.

**Thermal properties of barium oxide thermoelements.** N. I. Morgunin and V. S. Vagontsin (Kiev State Univ.). *Doklady Akad. Nauk S.S.S.R.* 50, 247-50 (1958). — With the aid of probes, in the form of Ni ribbons 7  $\mu$  thick and about 0.15 mm. wide, wound at different heights, at 3 different depths, 50, 70-100, and 150  $\mu$ , of a cylindrical oxide layer of total thickness 300  $\mu$ , deposited on a heated solid Ni cylinder core of 1.25 mm. diam., and with the aid of an opening in the oxide layer baring the core, the depth distribution of the current-voltage characteristics was investigated under voltage impulses of amplitudes up to 1500 v., time const. 50-600  $\mu$ sec., and frequency of the order of 1 hertz. With the aid of these same probes, the thermoelectromotive force  $E$  across the layer was determined between the core and each probe separately. At a certain stage of the activation, the sign of  $E$  changes into that corresponding to electronic conduction and then remains unchanged. The change occurs first at the innermost probe (closest to the core) and moves gradually towards the periphery of the oxide layer. Sometimes, a reverse change of sign of  $E$  occurs even on an activated layer on lowering the temp.:  $^{\circ}\text{C}$ . In one case, the "inversion temp." was 1100 $^{\circ}\text{K}$ . The total temp. drop across the oxide layer, from the core to the outer periphery, was about 100 $^{\circ}\text{C}$ . From the set of current-voltage curves at various depths, potential distribution curves were constructed in terms of the depth at various const. elevation current intensities  $i$  and temp.  $T$  (975-1100 $^{\circ}\text{K}$ ). These curves usually show slight breaks. Extrapolation to zero depth gives the potential jump  $\Delta E$  at the boundary of the core and the oxide layer; its value ranges from a few v.

to a few tenths of  $v$ , at low  $T$  and high  $\bar{n}$ ).  $\Delta V/V$  gives the contact resistance  $R_c$  at the same boundary;  $R_c$  is a function of  $\bar{n}$  and  $\mu_{\text{av}}$  through a mat. at lower  $T$  (975 and 1015°K.). If the thickness of the blocking layer is  $10^{-4}$ - $10^{-5}$  cm., the mean elec. field strength at the contact is of the order  $10^5$  v./cm. Further, the potential depth distribution curves give the total elec. resistance  $R_t$  between any 2 probes. Plots of  $R_t$  between the 1st and the 2nd probe, against  $\bar{n}$ , at various  $T$ , show that this resistance is ohmic only at higher  $T$  (1120°-1185°K.); at 975 and 1015°K.,  $R_t$  passes through a mat. The plots of  $R_t$  permit evaluation of several characteristic magnitudes; thus, the internal work function of the elec. material, the external work function  $\approx 0.9$  e.v., total  $\phi$  of the mat.  $\approx 0.8$  e.v., emission  $\phi_d \approx 0.5$  e.v.,  $\mu_{\text{av}}$  at  $T = 1120^\circ\text{K}$ ,  $\approx 10^4$  cm.<sup>2</sup>/sec., of free electrons in  $10^{17}$ - $10^{18}$  cm.<sup>-3</sup> and  $10^{19}$  cm.<sup>-3</sup> concn. of free electrons can be estd. to  $10^{17}$ - $10^{18}$  cm.<sup>-3</sup> and the surface concn. of free charges to  $10^{17}$ - $10^{18}$  cm.<sup>-2</sup>. Thus

11 Jan 1948

Chemistry - Barium Oxide  
Chemistry - Cathodes

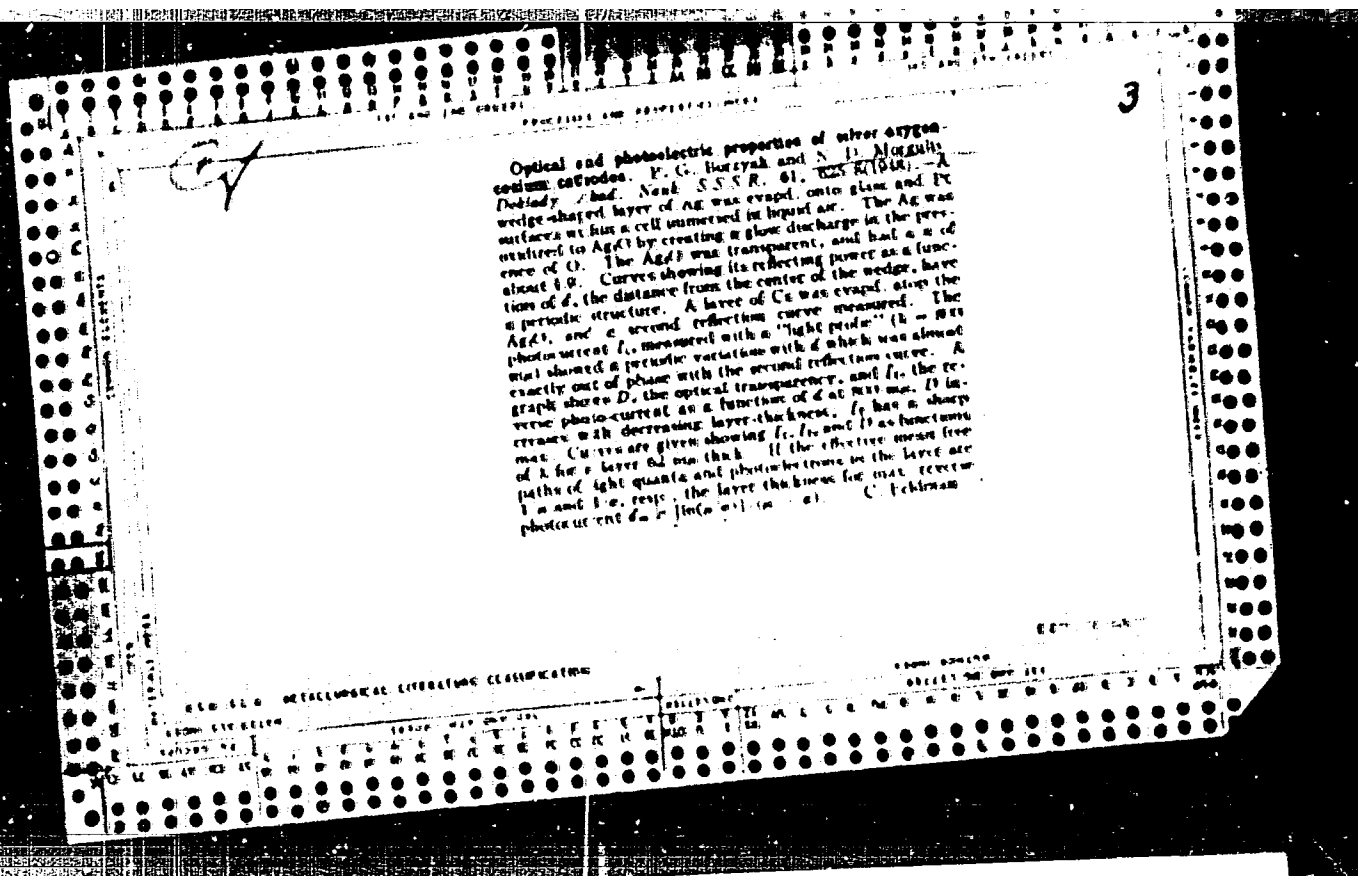
"Certain Physical Properties of Oxide-Barium Thermo-  
cathodes," N. D. Murgulis, V. S. Yagovdik, Kiev  
State U issue 1 T. G. Pavlenko, 4 pp

"Zhuk Abad Nauk SSSR, Nova Ser" Vol LII, No 2

Reports study of complex phenomena arising inside a  
real oxide thermocathode in the process of its elec-  
tronic emission. Presents series of experimental  
results, obtained for first time, characterizing  
volumetric properties of real effective oxide-barium  
thermocathodes. Data very useful to understand the  
processes arising in it and to construct new more

complete theory of thermoelectronic emission of ef-  
fective cathodes. Submitted by Academician S. I.  
Vavilov, 10 Nov 1947.

MURGULIS N. D.





1. MORGULIS, N. D.

2. USSR (600)

4. Physics and Mathematics

7. Physical Phenomena in an Oxidize Cathode. By S. V. Ptitsin. (Contemporary Problems of Physics., Leningrad-Moscow State Technical Press, 1949).  
Reviewed by N. D. Morgulis. Sov. Kniga, No. 7, 1950.

9. Report U-3081, 16 Jan. 1953. Unclassified.

14-00000, W. B.

PA 149T96

USSR/Physics - Photoelectricity  
Cathodes, Antimony-  
Cesium

Sep 49

"Letter to the Editor," N. D. Morgulis, P. G.  
Borzyak, B. I. Dyatlovitskaya, 2 pp

"Zhur Tekh Fiz" Vol XIX, No 9

Polenical reply to an article by Khlebnikov ("Zhur  
Tekh Fiz" Vol XIX, 134, 1949) who criticized  
authors' article, "Optical and Photoelectrical  
Properties of Antimony-Cesium Cathodes." Dis-  
cussion centered over depth of effective zone of  
photoeffect, which was calculated by authors to be  
approximately 10 millimicrons. Submitted 16 Feb 49.

149T96

MORGULIS, H. D.

G. Hermann and S. Wagener's book Oxide Cathode, translated from the German.  
Uspekhi. Fiz. Nauk 39, No 1, 1949.

MORGULIS, N.D.; KARKHANINA, N.Ya.

Some optical characteristics of antimony-cesium photocathodes.

Izv. zap. Kiev. un. 9 no.2:5-15 '50.

(MLRA 9:12)

(Photoelectric cells)

CAMORGULIS, N.D.

Some optical properties of secondary electron photo-cathodes. N. Ya. Karkhushina and N. D. Morgulis (Kiev State Univ.). *Zhur. Tekh. Fiz.* 36, 848-852 (1960); cf. *Doklady Akad. Nauk* 14, 988 (1947); *C.A.B.* 43, 324. The conclusion that the variations of the direct photoelectric current  $I$  along an Sb-Cs wedge are due to optical factors and not to inhomogeneities of structure, is supported by new data.  $I$  as a function of the incident wave length  $\lambda$  for thicknesses  $d$  of 5, 6, 7.5, 10, 60, 120, and 300 m $\mu$ . All spectral curves in this range coincide, with  $I_{\text{max}}$  at  $\lambda = 400$  m $\mu$ , and are independent of the nature of the substrate (Pt, Au, Al, or glass). Only in the immediate vicinity of the red limit of the curve (above  $\lambda = 600$  m $\mu$ ), does the height of the tail of the sensitivity curve increase somewhat with  $d$  from 10 m $\mu$  downward, and this effect is seen also on spectral curves of  $I$  per unit incident energy  $H$ . As this effect,  $d = 10$  m $\mu$  corresponds to the thickness of the layer which is the seat of the photoelectric effect, energy losses of the emitted photoelectrons will decrease with  $d$  decreasing below that depth, and the  $\lambda$  of the red limit will thus appear to

increase; moreover, the elec. field due to the contact potential difference between the Sb-Cs film and the Pt carrier surface should alter the energy losses in the layer and decrease somewhat the work function. For the reverse photo-effect, the max. of the spectral sensitivity curve of this layer (up to  $d = 60$  m $\mu$ ) lies at the same  $\lambda = 600$  m $\mu$  as for the direct effect, but is shifted to longer  $\lambda$  for thicker layers, owing to filtration of the light by the thick layers and the increase of the absorption coeff. with decreasing  $\lambda$ . Curves of  $I(\lambda)$  along the wedge (ordinate  $x$ ) for Sb-Cs layers on glass and on Al are in counterphase, as are the curves of the reflected light  $R(x)$ . For a layer on glass,  $I(x)$  and  $R(x)$  curves are also in counterphase. With the values of the refractive index  $n$  and the absorption coeff.  $k$ , the spectral curve of the fraction  $d$  of the incident energy absorbed in a layer of effective  $d \sim 10$  m $\mu$ , and  $R(x)$  can be calculated by Ives and Briggs (*J. Optical Soc. Am.* 33, 255 (1943)) for the influence of the red limit by multiplication by  $1 - (n/k)$ , coincides with the expel. spectral curve of the direct photoelectric effect for a thick Sb-Cs layer (per unit incident energy). This is added proof that the spectral curve of the Sb-Cs photocathode is valid, primarily by its optical constants. This conclusion is particularly, does not apply to Ag-O-Cs photocathodes. Contact of the Sb-Cs layer with Cs lowers the photoelectric sensitivity, probably owing

to formation of film of Cs, and suppresses the periodicity of the  $R(\lambda)$  curve. On the other hand, the  $R(\lambda)$  periodicity and the photodiode sensitivity can be enhanced with the aid of radiation which is transmitted through the Sb-Ca layer without absorption, e.g., by coating the outside of the bulb with a reflecting layer of Al. The effect of such an external Al mirror (which has no effect on the phase) extends up to thicknesses of the layer of approx. 200  $\mu$ . Combination of an Sb-Ca and an O-Cs photocathode in the same photodiode can give a photodiode effect with particular spectral features, as the Sb-Ca acts both as photocathode and anode for the O-Cs layer. The Sb-Ca layer responds mainly in the blue region, while the O-Cs layer responds mainly in the red region, which is easily transmitted by the Sb-Ca. The photodiode current of Sb-Ca is dead, mainly by its optical characteristics, whereas the photodiode current of the O-Cs layer is dead, by both the optical transmission of Sb-Ca and its transparency to the photocurrent from the O-Cs layer.

LA

Electron optical investigation of oxide cathodes. II. S. S. (1) Morgun and A. A. Deryugin (Kiev State Univ.). Izv. Akad. Nauk S.S.S.R., Ser. Fiz. 18, 464-7, (1961).—A half-spherical, indirectly heated oxide cathode was mounted in a spherical bulb covered inside with a semi-transparent layer of Au on which a fluorescent powder is pasted. With 6000 v. anode voltage the resolution of this projector was 2.5  $\mu$ . The voltage was applied either continuously or in 25  $\mu$ sec. pulses of repetition rate 10/sec. The field at the cathode in this latter case was about 10000 v./cm. In pulse operation the emission d. distribution is much more uneven than in d.c. operation. In some elements the c.d. can rise to 200  $\mu$ amp./sq. cm., the stationary emission being 10  $\mu$ amp./sq. cm. S. Pakser.

MORGULIS, N. D.

USSR/Physics - Thermoelectron Emission 11 Dec 51

"Experimental Investigation of the Oxide Cathode,"  
N. D. Morgulis, Ya. P. Zingerman, Inst of Phys,  
Acad Sci Ukrainian SSR, Kiev

"Dok Ak Nauk SSSR" Vol LXXXI, No 5, pp 783-785

Concludes that the thermo-emission of oxide cathodes must be detd by the phys properties of surface layer and not by the entire vol as was earlier (1941) believed. Verifies experimentally the fact of the existence of this layer and clarifies its peculiarities. Indicates the methods for completely solving this problem of verification. Submitted by Acad G. S. Landsberg 15 Oct 51.

210797



MORGULIS, E.D., otvetstvennyy redaktor; IMAS, V.I., redaktor; RAKHLINA, E.P.,  
techredaktor.

[Transactions of the conference on cathode electronics, held in Kiev  
on June 4-9, 1951] Trudy soveshchaniya po katodnoi elektronike: 4-9  
iunია 1951 g. Kiev, Izd-vo Akademii nauk Ukrainskoi SSR, 1952. 139 p.  
[Microfilm] (MLBA 7:10)

1. Soveshchaniye po katodnoy elektronike, Kiev, 1951. 2. Chlen-  
korrespondent AN USSR. (for Morgulis)  
(Electronics)



MORGULIS, N. D.

USSR/Physics - Semiconductor Cathodes, Jan/Feb 52  
Photoemission

"Investigation of Photo- and Secondary Electron  
Emission of Some Semiconducting Cathodes," N. D. Mor-  
gulis, P. G. Borzyak, B. I. Dyatlovitskaya

"Iz Ak Nauk SSSR, Ser Fiz" Vol XVI, No 1, p 121

Current article is a brief description of a report  
that appeared in Jubilee issue of 60th Birthday of  
S. I. Vavilov. States comparative investigation of  
some cathodes with similar optic characteristics but  
different integral sensitivity proved that the cause  
was related to a difference in photoelec output of  
electrons from filled zones.

218794

MORGAN, L. S. N. D.

# USSR .

✓Application of polar concepts to the theory of thermoelectronic emission of polar semiconductors. N. D. Mor-  
gan and E. N. Tolmachev (Inst. Phys., Acad. Sci. Ukr.  
SSR, Kiev). *Dokl. Akad. Nauk SSSR*, 1962, 24, 715-22.  
(1962). -M. and T. consider the peculiarities of the theory  
of thermoelectronic emission of polar semiconductors ex-  
hibiting isotropic emission and obtain the equation  
 $W_p = (kT/e) \ln(1 + 3/2 \exp(-\phi/kT))$  for Ba  
monocrystals containing admixture of 10 to 10<sup>4</sup> atoms of Ba  
per cm<sup>3</sup> of GaAs. From the exp. value of thermoelectronic  
emission  $W_p$  is 1.8 eV, the calculated value 1.6 eV, indicating  
a very good agreement for the general case of emission.

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MORGULIS, N. D.

USSR/Physics - Thermo-electric cathodes

Card 1/1 : Pub. 118 - 3/9

Authors : Morgulis, N. D.

Title : Modern thermo-electric cathodes

Periodical : Usp. fiz. nauk. 53/4, 501-543, Aug 1954

Abstract : Classification and characteristics of thermo-electric cathodes are given. Cathodes of the following materials are described: (1) pure metals (tungsten, tantalum); (2) metals coated with Monoatomic films; (3) various alkali-earth metal oxides; (4) various metal chemical-compounds; and (5) various metals and ceramic mixtures. Seventy references (1934-1954). Tables; diagrams; graphs.

Institution : ...

Submitted : ...

Translation ATIC-197737CB - FTS-8404/V

MORGULIS, N. D.

Nuclear Science Abstracts  
July 15, 1954  
Physics

EFFECTIVE DEPTHS OF SECONDARY ELECTRON  
EMISSION. N. D. Morgulis and N. G. Babitskiy.

U.S.S.R. Acad. Sci. Div. Phys. Math. Sci. (English transl.)  
Doklady Akad. Nauk S.S.S.R. 94, 1029-30 (1954) Feb. 21.  
(in Russian).

The effective depth of secondary electron emission in a number of metals and semiconductors was measured, and the results tabulated. The data were applied to a more generalised concept of the theory of electron emission. (J.S.R.)

9-21-54

EMZ

MORQULIS, N.D.

Developments in electronics in the Ukrainian Soviet Socialist  
Republic. Trudy Inst.fiz.AN URSR no.6:20-42 '55. (MLBA 9:8)  
(Ukraine--Electronics)

MORQULIS, N.D., professor.

Contributions of Kiev State University to the development of  
physical electronics. Nauk. zap. Kiev. un. 13 no.7:13-19 '55.  
(MLRA 9:12)

(Kiev--Electronics)



MORGULIS, N.D.

USSR/Optics - Physical Optics.

K-5

Abs Jour : Referat Zhur - Fizika, No 3, 1957, 7731

Author : Morgulis, N.D.

Inst :

Title : Contribution to the Theory of the Interference of Light  
in Thin Absorbing Films.

Orig Pub : Nauk. zap. kiyevs'k. un-t, 1955, 14, No 8, 183-187

Abstract : To clarify the optical properties of thin absorbing films, in particular the properties of photocathode wedges, a comparison is made of the reflection and transparency curves, obtained by calculation and experimentally. A theoretical calculation is made of the reflection and transmission curves of thin interference absorbing films, placed on various bases, including absorbing ones (metallic). From the coincidence of the experimental and calculated curves one determines the index of refraction and of absorption.

Card 1/1

- 35 -

USSR/Physics - Diffusion

FD-3123

Card 1/1 Pub. 153 - 22/24

Author : Morgulis, N. D.; Ptushinskiy, Yu. G.

Title : Diffusion of atoms of admixture (impurity) across near-contact layer of oxide cathode

Periodical : Zhur. tekhn. fiz., 25, No 6 (June), 1955, 1157-1159

Abstract : The authors discuss the introduction into cathode cores of suitable activating admixtures for the purpose of facilitating and accelerating the process of activation of oxide cathodes and maintaining them in the active state during the entire period of operation; and they consider the subsequent formation of a layer of barium orthosilicate  $\text{Ba}_2\text{SiO}_4$  possessing all the characteristics of the chemical blocking layer and exerting a negative influence upon the prolonged operation of the cathode. They consider in detail the causes for the appearance of this layer. On the basis of data presented on the process of activation and prolonged operation of oxide cathodes the authors expect that both nickel atoms themselves in the cathode cores and other admixtures hit the layer. Three references, including one USSR: Yu. G. Ptushinskiy, Author's abstract of candidate dissertation, Institute of Physics, Academy of Sciences of Ukrainian SSR, Kiev, 1954.

Institution :

Submitted : March 24, 1955

USSR/Physica - Vacuum technique

FD-3143

Card 1/1 Pub. 153 - 18/19

Author : Morgulis, N. D.

Title : Certain peculiarities of the ionizational method of obtaining very high vacuum

Periodical : Zhur. tekhn. fiz., 25, No 9 (September), 1955, 1667-1670

Abstract : The author states that the experience gained in his works of the past two years clearly indicates the necessity for cathode electronics of very high vacuum of  $p = 1/10^9$  mm, most expediently obtained by the comparatively simple and interesting ionizational method of D. Alpert (J. Appl. Phys., 24, 1953 and 25, 1954), whereas ordinary techniques give only  $p = 1/10^7$  mm. In connection with the very great interest and importance of this new method the author and associates conducted a number of experiments to clarify certain of the method's peculiarities. In the present work he gives the essence of part of these experiments and briefly expounds the results. He thanks D. A. Gorodetskiy, G. Ya. Pikus, O. V. Boyko, I. A. Romanova, and L. S. Khranovskaya for their participation in the experiments. Seven references: e.g. V. Gavriluk, "Author's abstract of candidate dissertation, Institute of Physics, Acad. Sci. Ukrainian SSR, 1954; D. A. Gorodetskiy, Sbornik: Tezisy dokladov na XII nauchnoy sessii KGU, sekts. fiz. [Symposium of Theses of reports at the 12th scientific session of Kiev State University, physics section], 1955.

Submitted : April 18, 1955

*Morgulis, N. D.*

USSR/ Physics - Molecular beam

Card 1/1 Pub. 22 - 22/49

Authors : Morgulis, N. D.; Gavriilyuk, V. M.; and Kulik, A. Ye.

Title : Condensation of a molecular beam on a metal surface

Periodical : Dok. AN SSSR 101/3, 479-482, Mar 21, 1955

Abstract : A quantitative experimental study of condensing molecules on metal surfaces is discussed. Special consideration was given to the condensation of strontium oxide molecules on very well milled tungsten bands. The method of marked molecules was used in the studies (a beam of radioactive molecules of isotope  $Sr^{89}$  was used for the marking strontium oxide molecules). The experiments were conducted with the help of a passive platinum evaporator at a temperature of  $T = 1350^\circ K$ . The density of the molecule beam was about  $10^{14}-10^{15} \text{ cm}^{-3} \text{ s}^{-1}$ . The results are presented in the form of diagrams. Ten references: 4 USSR, 4 USA, 1 French and 1 British. Graphs.

Institution : The Acad. of Sc., USSR, The Institute of Physics

Presented by : Academician S. A. Vekshinskiy, December 9, 1954

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from the... and the... of...  
197... and the... of...

1. The following information was obtained from the records of the Department of the Interior, Bureau of Land Management, regarding the land owned by the United States in the State of California:

1. *Journal of the American Medical Association*, 1997; 277: 1033-1038.

6-11-68

MORGULIS, N.D.

Category : USSR/Electronics - Gas Discharge and Gas-discharge Instruments H-7

Abs Jour : Ref Zhur - Fizika, No 2, 1957, No 4243

Author : Morgulis, N.D., Marchuk, P.M.

Inst : Institute of Physics, Academy of Sciences, Ukrainian SSR Kiev.

Title : Physical Phenomena Occurring when the Cathode of an Arc Discharge Works in Caesium Vapors.

Orig Pub : Ukr. fiz. zh., 1956, 1, No 1, 59-72

Abstract : An experimental investigation was made of the processes that determine the high emission activity of a thermal cathode of an arc discharge in caesium vapors at increased (approximately 0.5 mm mercury) pressure, when the emission density under continuous operation may reach tens of amperes per square centimeter. The high emission density is explained by the region where an active film of caesium can exist and have an optimum density for thermal emission shifts towards the higher cathode temperatures. The total cathode current is separated into an ionic and an electronic components. The peculiarities characterizing the basic thermal electronic portion of the discharge current are explained, as is the relative influence of the evaporation and

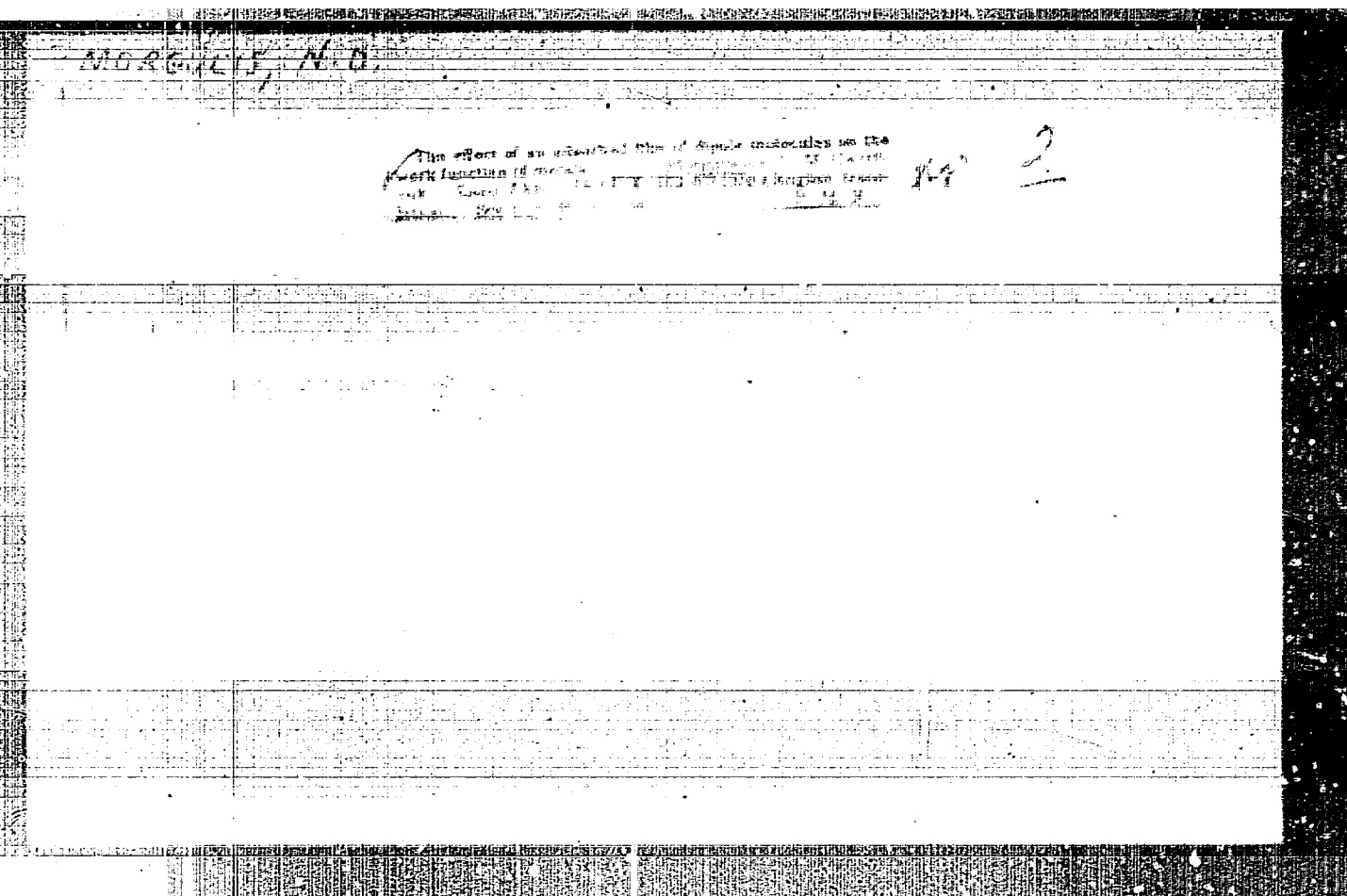
Card : 1/2

Category : USSR/Electronics - Gas Discharge and Gas-discharge Instruments H-7

Abs Jour : Raf Zhur - Fizika, No 2, 1957, No 4243

vaporization of the active caesium film on the cathode on the establishment of dynamic equilibrium in the cathode. The problem of the distribution of the energy in different parts of the gas discharge is considered briefly. Bibliography, 22 titles.

Card : 2/2





MORRIS, N. D.

2

1948  
REFLECTION OF SLOW ELECTRONS FROM THE SUR-  
FACE OF PURE TUNGSTEN AND FROM TUNGSTEN  
COVERED BY THIN FILMS. H. I. BOGUSLAVSKIY AND D. A.  
GORODENSKIY. Zh. tekh. fiz. 1948, 18, 10, 1701-1704.  
1949, 19, 1, 1-4. (English transl. in J. Appl. Phys. 20, 1, 1-4, 1949.)  
The reflection of slow electrons from the surface of  
tungsten and from tungsten covered with various films  
is studied. The results are shown in the form of graphs  
of the reflection coefficient as a function of the electron  
energy and the angle of incidence. The results show that  
the reflection coefficient is high for low energy electrons  
and decreases as the energy increases. The results also  
show that the reflection coefficient is higher for pure  
tungsten than for tungsten covered with films. The results  
are compared with the results of other workers. The  
correlation is also discussed between the threshold of  
secondary electron emission and the work function of the  
target. (Info)

MORGULIS, N. D.,

"Some Results and Aims of Research in the Field of Cathode Electronics," by N. D. Morgulis, Physics Institute, Academy of Sciences USSR, Izvestiya Akademii Nauk SSSR, Seriya Fizicheskaya, Vol 20, No 9, Sep 56, pp 977-992

The writer briefly describes the modern state of secondary electron emission, paying special attention to Soviet developments and leaving the subject to be treated with more detail in a later report by L. N. Dobretsov. The writer considers the following as particular problems still awaiting solution: the real activating factor of secondary emission; "memory" devices consisting in storage on dielectric surfaces; nuclear batteries using the beta-emission of  $Sr^{90}$  (W. Shorr, "Nuclear Batteries," Report No 171, International Conference on Atoms for Peace, Geneva, 1955; P. Happort, Phys. Rev., 93, 246, [1954]; and W. Pfaun and others, J. Appl. Phys., 25, 1422 [1954]).

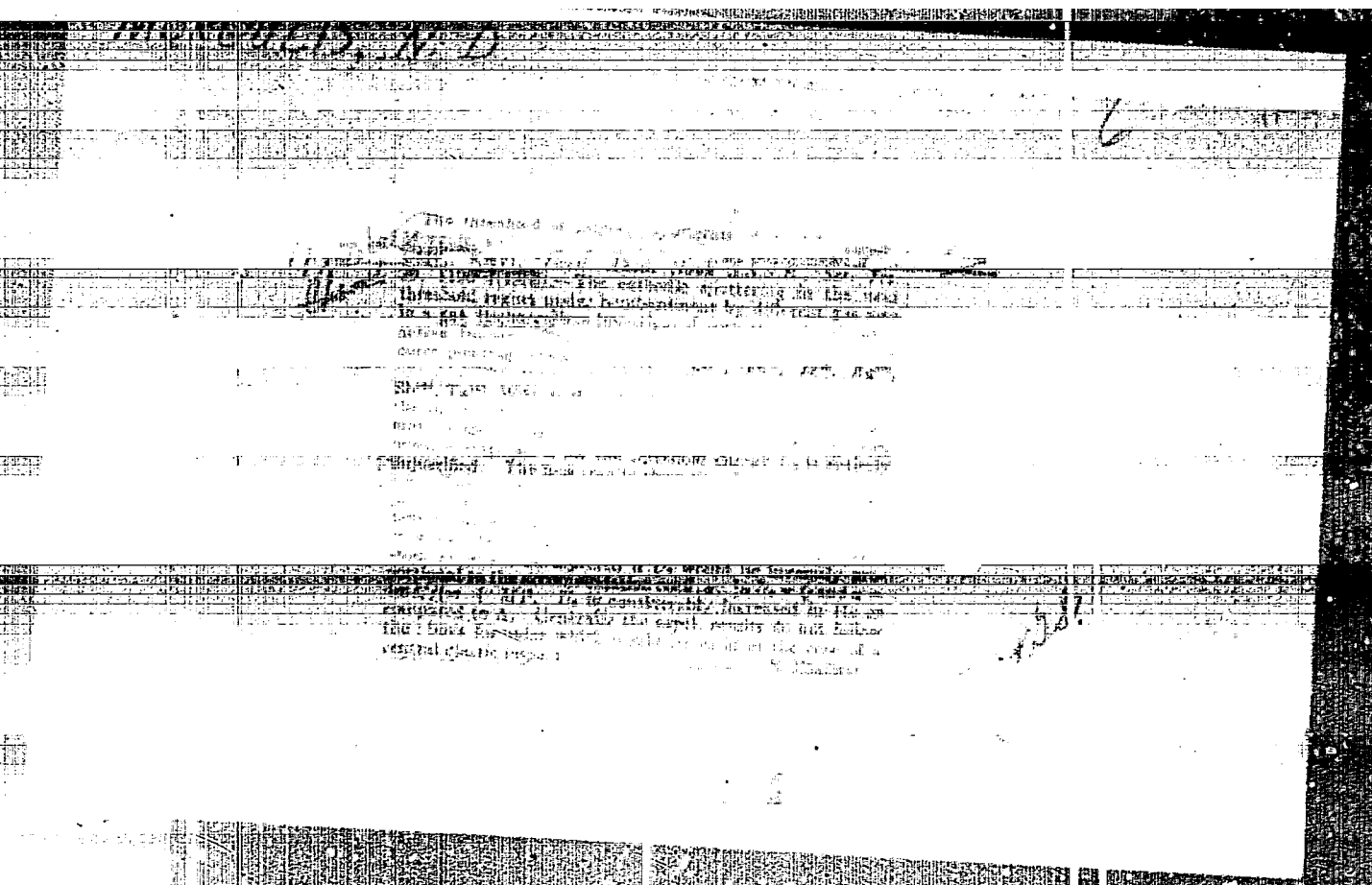
The various phenomena discussed in this report have a common basis in that they are generated by accelerated particles impinging on the surface of a solid body. This topic involves the following questions suggested for further research: energy transfer at collision and the subsequent scattering of incident particles; sputtering of the solid surface on heavy particle impact; electron exchange, i.e., the surface neutralization of ions; and finally, secondary electron emission.

The writer concludes that the main purpose of the conference should consist in the evaluation and in further development of these important problems.

Sam 1258

MOROUKIS, H. D.

Physics of porous metallic-film coated cathodes. Izv. Ak. SSSR Ser.  
fiz. 20 no.9:1067 8 '56. (KIRA 10:1)  
(Photoelectric cells)



MARGULIS, N.D.

2/29

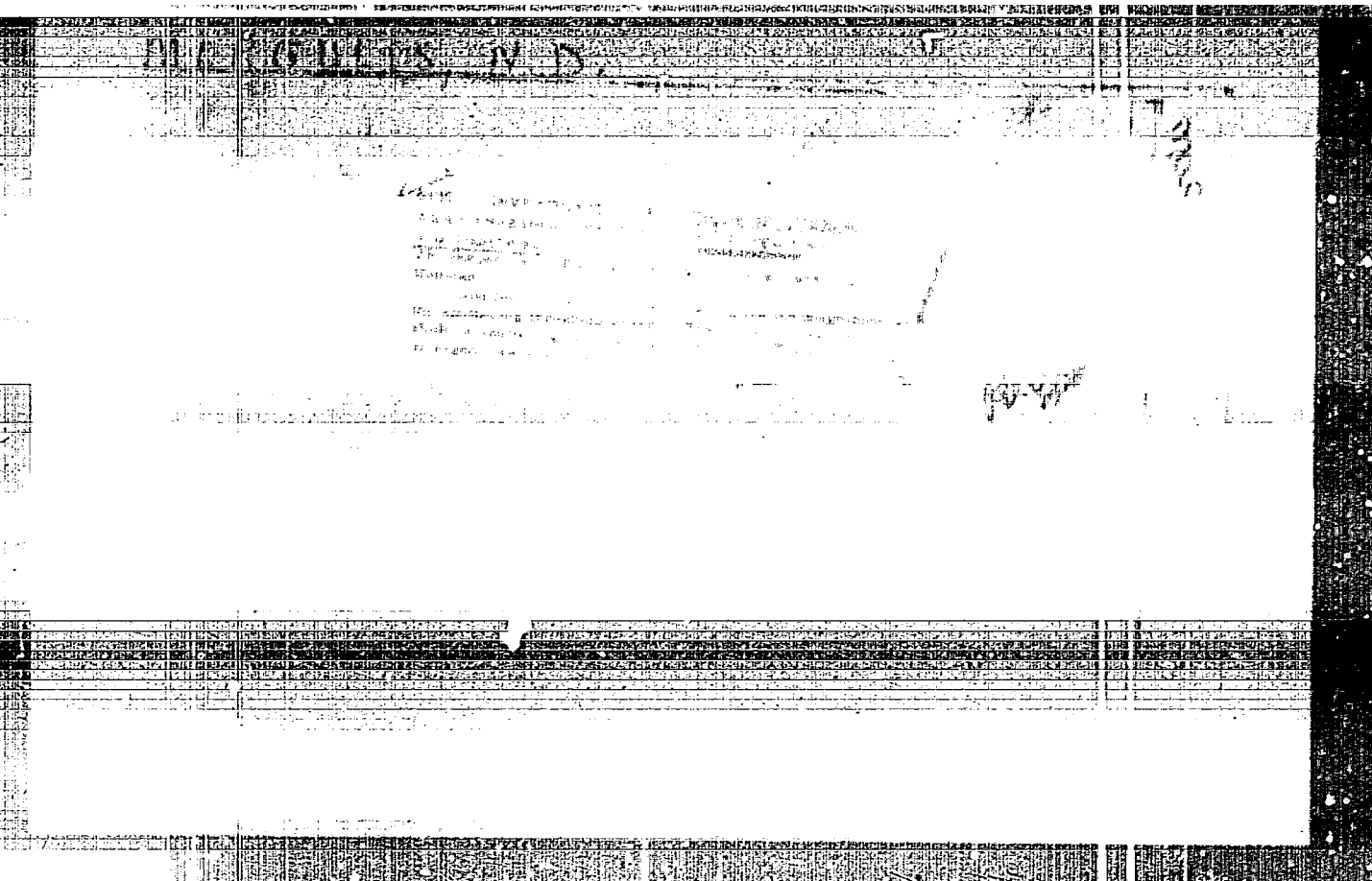
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9224\* Physical Properties of a Porous Metal-Cathode Thermocathode. Fleischer, G. *Journal of Applied Physics*, v. 28, no. 8, p. 2424-2426, 1957.

Physical problems associated with work on a thermocathode consisting of a W base coated with a monolayer film of Ba in a state of dynamic equilibrium. Problems of formation of Ba in the cathode chamber and subsequent diffusion and evaporation. Behavior of these cathodes in electron apparatus. Graphs, tables. 24 ref.

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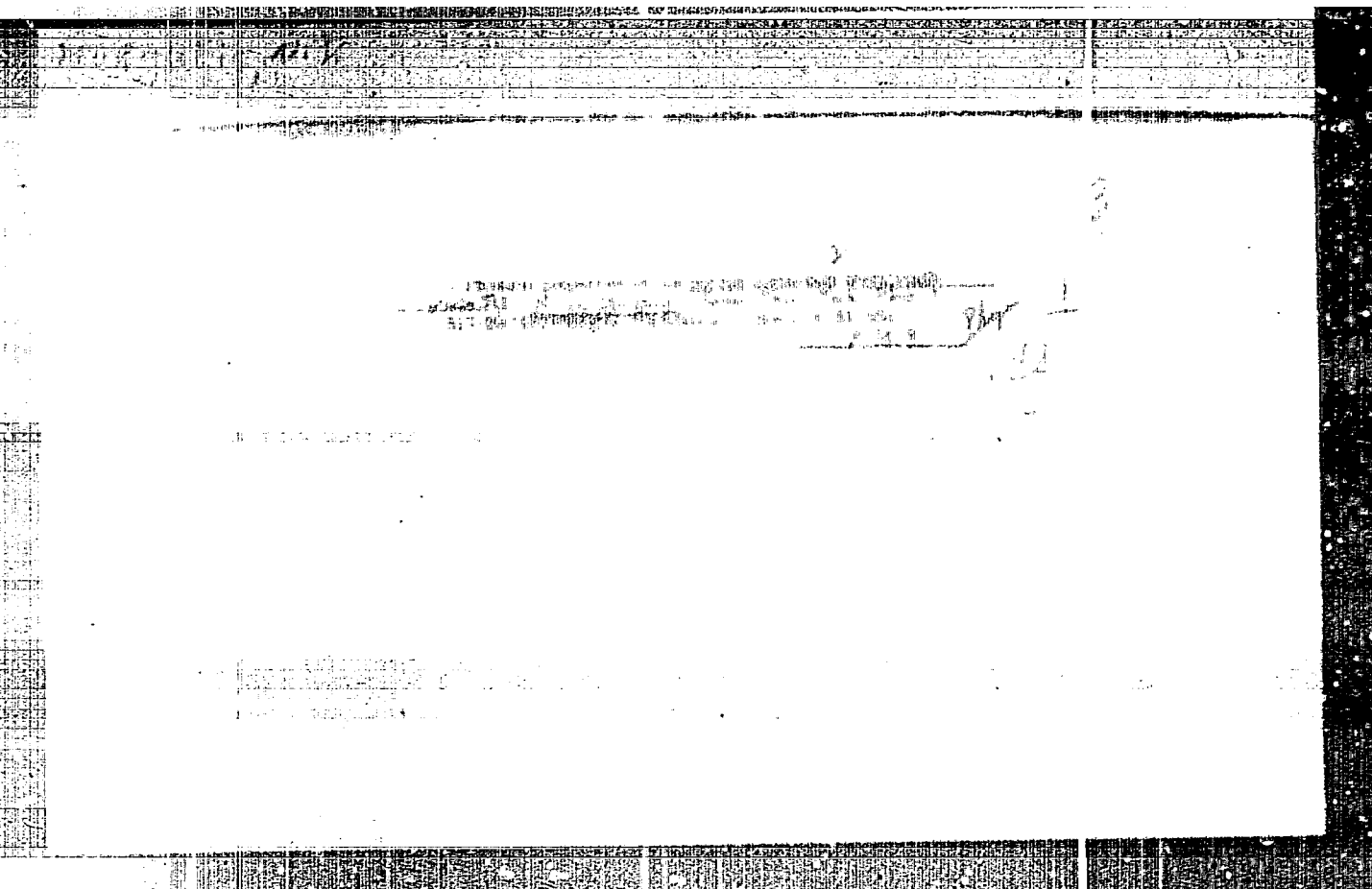






"APPROVED FOR RELEASE: 03/13/2001

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APPROVED FOR RELEASE: 03/13/2001

CIA-RDP86-00513R001135130004-3"

MORJULIS, H.D.; MARCHUK, P.M.

Transformation of heat energy into electrical energy by thermionic  
emission. Ukr. fiz. zhur. 2 no.4:379-380 O-D '57. (MIHA 11:3)

1. Institut fiziki AN URSR.  
(Thermionic emission)

MORGULIS, N.P.

109-11-8/8

AUTHORS: Morgulis, N.D. and Gavriluk, V.M.  
TITLE: 40 Years of Soviet Cathode Electronics (Sorok let sovetskoy  
katodnoy elektroniki)  
PERIODICAL: Radiotekhnika i Elektronika, 1957, Vol. II, No.11,  
pp. 1451 - 1467 (USSR).

ABSTRACT: An attempt is made by the authors to give a brief summary of the most important Soviet works and achievements in this field. The first electron tubes were produced in the Soviet Union in 1918 by M.A. Bonch-Bruyevich, who initiated a small-scale production of receiving tubes. The first investigations of the cathodes were carried out by several workers a few years later. In 1920, P.I. Lukinskiy and N.N. Semenov carried out first investigations of the photo effect. At the beginning of the Thirties, the work on cathode electronics was primarily carried out in a laboratory in Leningrad attached to the factory "Svetlana" and in a laboratory in Moscow. The Moscow laboratory was directed by P.V. Timofeyev and it was primarily interested in the investigation of the photo effect and the secondary emission. At about the same time, I.Ye. Tamm and S.P. Shubin proposed a theory of the photo effect which is valid up to the present day. The photo effect was also investigated quantitatively on Ag-Cs cathodes and on Sb-Cs cathodes.

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• 40 Years of Soviet Cathode Electronics.

109-11-8/8

bombardment of cathodes, investigation of the structure of metals by means of electron microscopy and investigation of gas discharges.

There are 174 Slavic references.

AVAILABLE: Library of Congress  
Card 3/3

MORGULIS, N. D.

109-12-1/15

AUTHOR: Morgulis, N.D.

TITLE: Physical Properties of and Design Criteria for the Porous Barium-tungsten Cathode (L-cathode) (Fizicheskiye svoystva i elementy rascheta poristogo bariy-vol'framovogo katoda)

PERIODICAL: Radiotekhnika i Elektronika, 1957, Vol.II, No.12, pp. 1471 - 1478 (USSR).

ABSTRACT: The present issue of the Journal (Vol.II, No.12) deals almost exclusively with the problems related to the properties of the L-cathode. The aim of this article is to summarise the material contained in all the following papers and to give some formulae which would facilitate the design of the L-cathode. In general, it is assumed that a porous barium-tungsten cathode consists of the following three elements: <sup>emitting</sup> surface, porous region and dispenser or camera. The physical processes of importance in the cathodes are: 1) uniformity of the surface emission; 2) dynamic equilibrium of the active surface layer as a function of temperature, ion bombardment and action of the chemically-active gases, and 3) diffusion of the barium vapours through the porous region on to the emitting surface. The above problems are briefly dealt with and formulae for determining the life and optimum emission conditions for the Card1/2 cathode are given.

109-12-1/15

Physical Properties of and Design Criteria for the Porous Barium-tungsten Cathode (L-cathode)

There are 3 figures and 10 references, 3 of which are Slavic.

ASSOCIATION: Physics Institute of the Ac.Sc. Ukrainian SSR, Kiyev.  
(Institut fiziki AN USSR, g. Kiyev)

SUBMITTED: May 8, 1957

AVAILABLE: Library of Congress  
Card 2/2

PA - 2150

AUTHOR:

MORGULIS, N.D.

TITLE:

Emission of Thermoelectrons of Seignette-Semiconductors.

PERIODICAL:

Zhurnal Tekhn. Fiz., 1957, Vol 27, Nr 2, pp 432 - 434 (U.S.S.R.)

Received: 3 / 1957

Reviewed: 4 / 1957

ABSTRACT:

This paper deals with the investigation of the thermoemission of a new class of non-metallic substances, the seignette-semiconductors, which probably belong to the polar type and have a high  $\xi$ -value. It was begun with  $\text{BaTiO}_3$ . After an explanation of its advantages and disadvantages the technology of cathode-production is described. The electron-emissions of the cathodes were measured in ordinary vacuum-diode-lamps. The following results were obtained: 1) Thermoemission of a pure titanate on the cathode core of nickel-silicate is about  $1020 - 1200^\circ\text{K}$  in the interval of  $1 - 20\text{mA.cm}^{-2}$ . In the case of a core of pure nickel results are less precise. 2) In the case of a double-layer-cathode the emission attained a considerably higher value within the same range of temperature, i.e.  $15 - 250\text{mA.cm}^{-2}$ . For comparison a double-layer-system was tried out, the exterior layer of which consisted of Thoriumoxide. Emissions were considerably less:  $0,5 - 15\text{mA.cm}^{-2}$ . 3) In the case of cathodes of mixed type at the same temperature emission was attained in an interval of  $10 - 180\text{mA.cm}^{-2}$ . 4) By means of a tungsten-detector also the

Card 1/2



MORGULIS, N.D.

Studies by scientists of the Ukraine in the realm of physical electronics. Vest. AN SSSR 27 no.5:51-55 My '57. (MLRA 1966)

1. Chlen-korrespondent Akademii nauk USSR.  
(Ukraine—Electronics)

01/10-8-9-7/51

AUTHOR: Moravskii, N. D., Corresponding Member, Academy of Sciences,  
USSR

TITLE: Problems of Cathode Electronics (Problemy katodnoy elektroniki)

PERIODICAL: Vestnik Akademii nauk SSSR, 1958, No 3, pp. 47-52 (USSR)

ABSTRACT: The most urgent task in cathode electronics is the experimental and theoretical investigation of physical problems dealing with the structure and properties of solids of different nature, and with their surfaces; by this means the electron emission of these bodies is determined. The other important task is the experimental and theoretical investigation of different kinds of electron emission, investigation of means of improving existing and creating new types of cathodes and the elaboration of new emission methods. The different kinds of electron emission can be divided into 3 types. The self-emission, which can be regarded as intrinsic property of the solid body, belongs to the first type, and the forced emission, which is caused by exterior influence exerted on the solid body, belongs to the second type. The first problem can be

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007/30-54-1-7/91

# Problems of Cathode Electronics

solved by creating coatings of electropositive elements. The second problem is connected with the bulk electron properties of solids, mainly of semiconductors, and with the intensification of the excitation process of their free electrons. It is reasonable to divide the emission process into 2 or 3 parts: the excitement of the electrons in the solid; their motion towards the surface of this body and the release into the vacuum. Investigations of photo- and secondary electron emissions in the last years have been carried out by using solids of non-metallic nature (semiconductors and dielectrics). Then investigating the excitement process of the electrons in the solid during a bombardment with fast primary electrons, above all the problem of the nature of excitation of the electrons in connection with the secondary emission as well as the additional conductivity of the cathodes arises. In the second stage of emission, of the forced type emission, the interaction of slow excited electrons with a solid can be found. During the last years in the Soviet Union, an intensification of work in the field of cathode electronics and an augmentation of its quality has been observed in the institutions of the AS USSR, the academies of the Union Republics and in universities and industrial scientific organizations. Nevertheless,

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Problems of Cathode Electronics

SOV/30-90-9-7/51

less, the situation has to be regarded as unsatisfactory and requires an intensification of this research.

Card 3/3

*MORGULIS N. D.*

30-2-59/49

AUTHOR: None Given

TITLE: Cathode Electronics Research (Raboty po katodnoy elektronike).  
All-Union Conference in Leningrad (Vsesoyuznoye soveshchaniye  
v Leningrade)

PERIODICAL: Vestnik Akademii Nauk SSSR, 1958, Nr 2. pp. 100-108  
(USSR)

ABSTRACT:

The 8th conference was held from October 17 to October 24, 1957 in Leningrad. More than 500 representatives of scientific research institutions and industrial firms of the country took part as well as guests from abroad. S. A. Vekshinskiy opened the conference. N. D. Morgulis gave a report on "40 Years of Soviet Cathode Electronics". He gave a detailed description of the investigation of Soviet scientists and engineers in this field, and of the positive influence on the improvement of technological processes. The main work of the conference was done in the sections for thermal electronic-, photoelectronic-, and autoelectronic emissions, for technology, for gas discharge, and for ionic processes. In 20 meetings 120 reports were given. The participants visited scientific research laboratories and places of production in Leningrad

Card 1/2

Cathode Electronics Research. All-Union Conference in  
Leningrad

30-2-39/49

in order to get acquainted with works in the field of  
cathode electronics.

AVAILABLE:

Library of Congress

1. Electronics-USSR
2. Scientific research-Electronics

Card 2/2

MORGULIS, N.D.; MARCHUK, P.M.

Investigation of a cesium arc rectifier [In Ukrainian with summary  
in English]. Ukr.fiz.zhur. 3 no.1:95-103 Ja-Y '58. (MIRA 11:4)

1. Institut fiziki AN URSR.  
(Cesium) (Electric current rectifiers)

66260

SOV/181-1-7-16/21

~~24(6)~~ 24.7700

AUTHOR: Morgulis, N. D.

TITLE: Change of Work Function of Electron From Metal Under the Influence of an Adsorbed Film of BaO Molecules

PERIODICAL: Fizika tverdogo tela, 1959, Vol 1, Nr 7, pp 1125-1132 (USSR)

ABSTRACT: The temperature dependence and the influence of the kind of metal base on the work function of electrons as well as the characteristic properties of monomolecular mixed layers on a metal base were experimentally measured. The author further tried to measure that part of the work function in the system BaO-Ni, that is a function of the eigen-dipole moment of BaO. The experimental set consisted mainly of a previously described tube. In all cases rolled tungsten strip was used for the base, coated by the different layers in question. The change of the contact potential was determined by the shifting of the initial volt-ampere-characteristics of the electronic current. Among others the following layers were examined: BaO-W, Cl-W, Ba-O-W, BaO-O-W, BaO-Pt, BaO-Ga, BaO-Be, BaO-Ta, BaO-InSb, BaO-Ag<sub>2</sub>Te (Figs 2,3,5,6). On the strength of the results of

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66260

SOV/181-1-7-16/21

Change of Work Function of Electron From Metal Under the Influence of  
an Adsorbed Film of BaO Molecules

measurement the change of the work function of electrons in the layer substance is discussed and an attempt is made to explain the common nature of this phenomenon. This investigation was shared by the following scientists, who contributed also pertinent publications: V. M. Gavriilyuk, G. Ya. Pikus, D. A. Gorodetskiy, Yu. S. Vedula, and Yu. G. Ptushinskiy. There are 7 figures and 16 references, 8 of which are Soviet.

ASSOCIATION: Gosuniversitet, Kiev (State University, Kiev)

SUBMITTED: June 25, 1958

Card 2/2

66277

SOV/181-1-11-12/27

~~24(6)~~ 24.7700

AUTHORS:

Vedula, Yu. S., Gavriluk, V. M., Morgulis, N. D.

TITLE:

On the Electronic and Adsorption Properties of Films of Barium Atoms on the Surface of Tungsten Coated With Oxygen

PERIODICAL:

Fizika tverdogo tela, 1959, Vol 1, Nr 11, pp 1717 - 1719 (USSR)

ABSTRACT:

Investigations were carried out to establish whether Ba-O-W-films are suitable for thermal cathodes. A measure for the suitability is the work function ( $\phi$ ) of the electrons and the increased adsorption stability of these layers. The measuring method is described in detail in reference 1. The films Ba-O-W ( $\phi_K = 5.1$  ev, 5.5 ev, 5.9 ev, 6.5 ev) were examined in the temperature range 800 - 2000°K. The measuring results are graphically presented in figure 1. It is remarkable for the Ba-O-W-system that a noticeable irregularity occurs from 1400 - 1500°K, which still has to be clarified. Comparing the Ba-O-W-system with the BaO-W-system it appears as if, in the BaO-W-system, the BaO-molecule would completely evaporate, while it seems that in the other system the Ba and the O evaporate separately. One could conclude from this fact that the two systems are not

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On the Electronic and Adsorption Properties of Films of Barium Atoms on the Surface of Tungsten Coated With Oxygen SOV/181-1-11-12/27

identical. Further examinations were made to establish whether the systems O-Ba-W and Ba-O-W are identical (Fig 2). The measuring results point to the fact that the two systems are not of the same valency, but that the system O-Ba-W easily changes over to the system Ba-O-W, which is the more favorable and is more stable energetically. There are 2 figures and 4 references, 3 of which are Soviet.

ASSOCIATION: Institut fiziki AN USSR, Kiyev ( Institute of Physics of the AS UkrSSR, Kiyev)

SUBMITTED: March 24, 1959

Card 2/2

AUTHORS: Morgulis, N.D. and Naumovets, X.G. SOV/109-4-6-26/27  
 TITLE: The Problem of Converting the Thermal Energy Into  
 Electrical Energy by Employing Thermal Electron Emission  
 (Letter to the Editor) (K voprosu o preobrazovanii  
 teplovoy energii v elektricheskuyu putem ispol'zovaniya  
 termoelektronnoy emissii) (Pis'mo v redaktsiyu.)

PERIODICAL: Radiotekhnika i elektronika, 1959, Vol 4, Nr 6,  
 pp 1065 - 1066 (USSR)

ABSTRACT: The authors commenced the investigation of this problem  
 in 1949 and some of the results obtained were published  
 in a number of articles (N. Morgulis and P. Marchuk  
 - Ref 2). Similar work has been done in America and  
 the results were published at a later date in a number  
 of papers (K. Hernquist et al. - Ref 1). The authors  
 point out that another type of energy conversion by  
 thermoelectronic means is also possible. This method  
 was studied experimentally by employing a special tube  
 provided with an L-cathode fitted with a tungsten plug  
 having a diameter of 3 mm; the tube had an anode with a

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SOV/103-4-6-26/27

The Problem of Converting the Thermal Energy Into Electrical Energy  
by Employing Thermal Electron Emission (Letter to the Editor)

protective ring and the distance between the electrodes was 2 mm. A drop of caesium was introduced into the tube and its vapour pressure was kept constant at a temperature  $t$  by means of a thermostat. When a negative potential was applied to the anode, a large ion current was observed. When the electrodes were shorted, a large electron current  $I_e$  was obtained; the magnitude of  $I_e$  could be controlled by the vapour pressure and the cathode temperature  $T$ . It was found that at  $t = 180^\circ\text{C}$  and  $T = 1300^\circ\text{C}$ , the ion current at  $-90\text{ V}$  was  $20\text{ mA/cm}^2$ ; the short-circuit current was  $I_e = 2.0\text{ A/cm}^2$ ; the optimum useful power was  $0.6\text{ W/cm}^2$  and the efficiency was about 5%. It is thought that the performance of this type of energy-converting device could be improved further.

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SOY/109-4-6-26/27  
The Problem of Converting the Thermal Energy Into Electrical Energy  
by Employing Thermal Electron Emission (Letter to the Editor)

ASSOCIATION: Institut fiziki AN USSR, Kiyev (Institute of  
Physics of the Ac.Sc., Ukrainian SSR, Kiyev)

SUBMITTED: February 9, 1959

Card 3/3

8/194/62/000/012/073/101  
D295/D308

AUTHOR: Morgulis, N. D.

TITLE: The application of new techniques to investigations in the field of physical cathode electronics

PERIODICAL: Referativnyy zhurnal, Avtomatika i radioelektronika, no. 12, 1962, 56, abstract 12 Zh 349 (Nauk. zap. Kyyivs'k. un-t, v. 18, no. 3, 1959, 167-171 (Ukr.; summary in Rus.))

TEXT: Recent work carried out at Kiev State University in the field of physical cathode electronics is briefly reviewed. In mass-spectrometry all-welded glass analyzer-tubes have been used which made it possible to improve the vacuum in them and to investigate the composition of gas liberated during activation and operation of an oxide cathode, the emission of negative ions from an oxide cathode, as well as the characteristics of getter and ionic exhaust action in high-vacuum systems. The pressure of the adsorbed component of residual gases has been determined by the flash me- ✓

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S/194/62/000/012/073/101  
D295/D308

The application of new ...

thod. The influence of residual gas adsorption on the reflection of slow electrons and on the work function of the surface of some solid bodies is investigated. It is shown that reliable values of the reflection coefficient can only be obtained under super-high vacuum. The diffraction of slow electrons from a pure and a barium-film coated surface of a W monocrystal is investigated. Cathode sputtering is investigated in the region of small energies of the sputtered ions by means of radioactive indicators. [Abstractor's note: Complete translation.] ✓

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66166

40-37

AUTHORS:

Morgulis, M. D., Ptushinskiy, Yu. G.,  
Chuykov, B. A.

SOV/20-128-5-18/67

TITLE:

Some Specific Features of the Partial Adsorption of Residual  
Gas Components at Very High Vacuum

PERIODICAL:

Doklady Akademii nauk SSSR, 1959, Vol 128, Nr 5, pp 930-932 (USSR)

ABSTRACT:

In the present paper the authors investigate the properties of a "natural" mixture of residual gases generally present in electronic devices at high vacuum. For this investigation the authors use a mass spectrometric device intended for investigations in the field of high-vacuum processes. The inside of the mass spectrometric analyzer tube employed was fitted with a long tungsten band. This tube consisted wholly of glass and was soldered. The pressure of the residual gases was  $p \sim 1 \cdot 10^{-8}$  torr. The tungsten band served as the basis on whose surface the components of the residual gases investigated were adsorbed. A schematic representation of the mass spectrum of these gases is given in a figure. The present problem was investigated by the well-known "flash" method. The relative degree of adsorption  $\Delta I/I_m$  of each component of this mixture

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Some Specific Features of the Partial Adsorption  
of Residual Gas Components at Very High Vacuum

SOV/20-126-5-18/67

may be determined from data given in the above-mentioned  
figure. This degree of adsorption is proportional to the mean

condensation probability  $\bar{k}_m : \frac{\Delta I_m}{I_m} = \frac{BN_{m,q_n}}{AP_{m,q_n}} = C\bar{k}_m$ , where  $N_m$

denotes the total amount of gas adsorbed within the given time.  
The following interesting conclusion is arrived at:

$\bar{k}_m(\text{He}) = 0$ ,  $\bar{k}_m(\text{H}_2) \approx \bar{k}_m(\text{N}_2)$ . In order to obtain more exact  
data on the specific features of adsorption of each gas  
component in the mixture, the partial adsorption rates were  
determined by measuring the dependence of the quantity  $\Delta I_m$   
on the time  $t$  of previous adsorption exposure. This  
dependence is represented in a diagram for the 2 main components  
 $\text{H}_2$  and  $\text{N}_2$ . For comparison, the dependence  $\Delta I$  is shown for  
the total "flash" of all gases in the ion source. The total  
pressure of the gases amounted to  $p' \approx 1 \cdot 10^{-8}$  torr. The  
desorption of the components  $\text{H}_2$  and  $\text{N}_2$  from tungsten after  
extremely long exposure of the latter in the residual gas atmosphere

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Some Specific Features of the Partial Adsorption of  
Residual Gas Components at Very High Vacuum

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SOV/20-128-5-18/67

can be investigated more closely by means of the temperature variation with respect to time. In doing so, the authors observed the polyphase nature of the adsorbed states of  $H_2$  and  $N_2$  on tungsten, which complicates this phenomenon even more. The third diagram gives the characteristics of partial dependence on adsorption of the "pumping out" of the gas components  $H_2$  and  $N_2$  from the mixture of residual gases, after the tungsten band had been freed from these components by "flashing" at high temperatures and then cooled. The curves shown in figure 2 are qualitative representations of the integrals of the curves given in figure 3. Investigations of this problem are being continued. There are 3 figures and 2 references, 1 of which is Soviet.

ASSOCIATION: Institut fiziki Akademii nauk USSR (Institute of Physics  
of Sciences, Ukr SSR) / of the Academy

PRESENTED: March 27, 1959, by I. V. Obreimov, Academician

Card 3/4

Some Specific Features of the Partial Adsorption of  
Residual Gas Components at Very High Vacuum

66166  
SOV/20-128-5-18/67

SUBMITTED: March 16, 1959

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S/120/60/000/005/026/051  
E032/E314

AUTHORS: Morgulis, N.D. and Marchenko, R.I.

TITLE: Some Ionisation Methods of Measuring Very Low Pressures

PERIODICAL: Pribery i tekhnika eksperimenta, 1960, No. 5, pp. 106 - 108

TEXT: The Alpert gauge is almost universally used to measure very low pressures ( $\leq 10^{-8}$  mm Hg). Although it is a very simple device it is far from being perfect. It has a relatively low sensitivity and therefore requires relatively complicated ion-current amplifiers. The principal disadvantage, however, is the fact that its lower pressure limit is still too high. The present authors describe various methods for improving the Alpert gauge. Fig. 1a shows one of these modified forms of the Alpert gauge. In this gauge the electron current is injected into the anode I, which is in the form of a cylindrical grid with closed ends. The system incorporates a simple Wehnelt cylinder and an electron reflector III. The ion-collector IV is in the form of a very thin wire at a small and, if possible, the same negative

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85354

S/120/60/000/005/026/051  
E032/E314

# Some Ionisation Methods of Measuring Very Low Pressures

potential as on the electrodes II and III. A coil is wound on the outside of the glass envelope and produces a small magnetic field  $H$ . Use of the electron reflector and the magnetic field increases the mean free path, i.e. the ionising power, and the almost field free space inside the anode enables the positive ions to leave this space more easily. This kind of manometer has a lower pressure limit of

$10^{-9}$  mm Hg. With  $H = 150$  Oe the sensitivity of the manometer was found to be  $120 \text{ mm}^{-1}$  and this is higher by an order of magnitude than the sensitivity obtained with the Alpert gauge. The present authors have also investigated the design reported by Houston and Alpert in Ref. 2. This design is shown schematically in Fig. 16. The gauge consists of a closed anode I, a reflector II and an ion-collector III. The electrode system is located in a strong longitudinal magnetic field. It was found that with this design the ion current depends linearly on the pressure and the sensitivity is extremely

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E032/E314

Some Ionisation Methods of Measuring Very Low Pressures

large (of the order of  $10^6 \text{ mm}^{-1}$ ). Although the present authors have investigated this gauge only in the range

$\sim 10^{-8} - 10^{-7}$ , they are of the opinion that owing to the high sensitivity this gauge would be very suitable for pressures

$\ll 10^{-9} \text{ mm Hg}$ . It is therefore suggested that this manometer should be further investigated.

There are 5 figures and 5 references: 4 English and 1 Soviet.

ASSOCIATION: Kiyevskiy gosudarstvennyy universitet  
(Kiyev State University)

SUBMITTED: July 13, 1959

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85167

26.1632

9.3/20 (1137, 1138, 1131)

8/139/60/000/005/023/031

E192/E182

AUTHORS:

Morgulis, N.D., and Korchevov, Yu.P.

TITLE:

Electronic and Ionic Emission of Metal-film Cathodes  
(L-cathodes) in Caesium Vapours

PERIODICAL: Izvestiya vysshikh uchebnykh zavedeniy, Fizika,  
1960, No. 5, pp 137-142

TEXT:

The investigation of electron and ion emission of L-cathodes in an atmosphere of alkaline metals is of considerable interest since it can yield information on the relative electron emissivity of the cathode coatings. The problem was investigated experimentally by employing the tubes constructed by K.Morgulis and Naumovets (Ref. 1). The tubes were provided with disc cathodes having a diameter of 3 mm. The cathodes were of two types: 1) a porous Ba-W L-cathode, and 2) a Ba-Ni pressed cathode. A disc anode having a diameter of about 1 mm was situated at a distance of  $< 1.5$  mm from the cathode; the anode was provided with a protective ring so that it was possible to measure the electrons  $I_e$  and ion  $I_p$  emission of the central uniform portion of the cathode. A drop of metallic caesium was introduced in the tube and the vapour pressure  $p$  of this

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S/139/60/000/005/023/031

E192/E182

Electronic and Ionic Emission of Metal-film Cathodes (L-cathodes)  
in Caesium Vapours

substance could be determined from the temperature  $t$  of the tube envelope. By employing a strong transverse magnetic field it was possible to ensure that the ion current of the tube had no external electron components. The electron-emission components are shown in Fig. 1. These illustrate the dependence of  $I_e$  on cathode temperature  $T$  for two vapour pressures:  $p = 3 \times 10^{-6}$  mm ( $t = 25^\circ\text{C}$ ), and  $1 \times 10^{-2}$  mm ( $t = 150^\circ\text{C}$ ). These equilibrium relationships are illustrated by the solid curves in Fig. 1 for  $t = 25^\circ\text{C}$ , and by the dotted lines for  $t = 150^\circ\text{C}$ . The currents were measured by means of microsecond rectangular pulses. The curves marked I refer to Ba-W, while curves II are for the Ba-Ni cathode; the vertical scales for the two curves are different. Analysis of these curves shows that: 1) the specific emissivity of the two cathodes has the usual value; 2) at  $t = 150^\circ\text{C}$  the curves of  $I_e$  at 700-800 °C have a minimum, this being due to the partial desorption of the Cs film from certain areas of the cathode surfaces; 3) the righthand-side portions of

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both the curves for  $t = 150$  °C are much higher at temperatures between 800 and 1000 °C than those determined for 25 °C;  
4) at  $t = 150$  °C the electron emission of a Ba-Ni cathode has a very high value even at low temperatures. Both the cathodes showed a strong thermal ionisation of Cs which manifested itself in the presence of appreciable ionic current. This effect is illustrated in Fig. 2, where the ion current is plotted as a function of the cathode temperature. Curve I characterises the thermal ionisation of Cs atoms on the surface of the Ba-W cathode, while Curve II shows the same effect for the Ba-Ni cathode. These curves were taken at  $p = 2 \times 10^{-4}$  mm, which corresponds to  $t = 80$  °C. From Fig 2 it is seen that a considerable increase of  $I_p$  with temperature is observed. This indicates that the cathodes contain micro regions where the active coating has been removed; the size of these regions rapidly increases with cathode temperature. Further measurements for the Ba-W cathode are shown in Fig. 3 where the temperature range extends from 1000 to 1300 °C; the curves in Fig. 3 give the electron emission

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at  $t = 25^{\circ}\text{C}$  (solid line) and  $150^{\circ}\text{C}$  (dotted line) as well as the ion emission at  $80^{\circ}\text{C}$ ; these curves can be regarded as the continuation of the curves of Figs 1 and 2 for higher temperatures. Curves showing the dependence of the electron current  $I_e$  (at  $T = 900^{\circ}\text{C}$ ) and ion current  $I_p$  (at  $T = 1000^{\circ}\text{C}$ ) on the Cs vapour pressure ( $t = 80-180^{\circ}\text{C}$ ) for the Ba-Ni cathode are given in Fig. 4. Here it is seen that though  $I_p$  increases, the coefficient  $\alpha = I_p/I_{p0}$  (where  $I_{p0}$  is the value of the ion current calculated under the assumption that all the atoms of Cs impingeing on the cathode are ionised) shows a considerable decrease: a similar effect is observed in the Ba-W cathode. This is due to the shift of the adsorption equilibrium towards the increase of the coverage of the cathodes by Cs, i.e. towards the reduction of the uncovered portion of the cathode surface. There are 4 figures and 9 references: 2 English and 7 Soviet.

ASSOCIATION: Kiyevskiy gosuniversitet imeni T.G. Shevchenko  
(Kiyev State University imeni T.G. Shevchenko)

SUBMITTED: October 9, 1959  
Card 4/4

81367

S/181/60/002/05/26/028  
B006/B017

24.2700

AUTHORS: Morgulis, M. D., Naumovets, A. G.

TITLE: Utilization of Thermoelectric Emission for Direct  
Conversion of Thermal Into Electric Energy

PERIODICAL: Fizika tverdogo tela, 1960, Vol. 2, No. 3, pp. 537-542

TEXT: In the introduction, the authors refer to the great importance of direct conversion of thermal into electric energy, and mention a monograph by A. F. Ioffe in which "vacuum thermocouples" were suggested. Some theoretical results of a previous paper (Ref. 2) are also dealt with in detail, and the results of a number of publications are discussed, above all, with respect to the investigation results obtained with tungsten L-cathodes. For verifying the various results, test tubes were produced with plane tungsten L-cathodes and small anodes (electrode spacing:  $\approx 2\text{mm}$ ); a drop of metallic cesium was introduced into the tubes so that the cesium vapor pressure  $p$  depended on the temperature of the thermostat which contained the test tube. The cathode temperature  $T$  was measured with an

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Energy

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optical micropyrrometer, from which the cathode output was determined. A negative voltage  $V$  of 50 - 100 v was applied to the anode, and a relatively high ionic current  $I_p$  was observed, which steeply rose with increasing  $p$  and increasing  $T$ .  $|I_p|$  was considerably higher than would have corresponded to the  $3/2$ -law. The compensation effect of the ionic space charge due to the thermal electrons of the L-cathode was investigated. Fig. 1 shows the brightness temperature  $T_{br}$  as a function of  $I_p$  (Curve I), and Fig. 2 shows  $T_{br}$  as a function of the short-circuited electron current  $I_{e0}$ . An investigation of the dependence of  $I_p$  on  $I_{e0}$  showed that  $I_p$  may be set equal to  $I_{e0}/k$ , with  $k = \frac{1}{2} \sqrt{\frac{M}{\pi}}$  (Curve II); the

actual value of  $I_p$  corresponds to a  $k' < \frac{1}{2} \sqrt{\frac{M}{\pi}}$  and lies between the two

Curves I and II. Fig. 1 shows the ratio  $\alpha = I_p/I_{p0}$ , and Fig. 2 analogous  $\beta = I_{e0}/I_0$ , computed from the Richardson formula. Fig. 3 shows the static characteristics, i.e., the function  $I_{e0}(V)$  with small  $V$  for the brightness temperature  $1,280^\circ\text{C}$ . Fig. 4 shows the load characteristics, i.e., the

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resistance dependences of the output  $W_R = I_e^2 R$  on  $V_R = I_e R$  and  $I_e$  are shown. Fig. 5 shows  $W_R(T_{br})$ . Finally, Fig. 6 gives the curves analogous to Fig. 4 for special parameters ( $T_{br} \approx 1,500^\circ C$ ,  $I_{e0} \approx 2.0$  a/cm<sup>2</sup>, output  $\approx 0.6$  w/cm<sup>2</sup>,  $\eta \approx 5\%$ ). The cathode area in the experiments was 0.07 cm<sup>2</sup>. These results are compared with those of Ref. 3, where higher efficiencies were obtained. The experimental results of the present paper indicate a new possibility of obtaining high  $I_{e0}$  and  $\eta$  at relatively low cathode temperatures. In conclusion, the authors thank V. A. Morozovskiy for having supplied the test tubes. There are 6 figures and 11 references: 7 Soviet and 4 English.

ASSOCIATION: Institut fiziki AN USSR Kiev (Physics Institute of the  
AS UkrSSR, Kiev)

SUBMITTED: May 4, 1959

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25573

S/185/60/005/002/008/022  
D274/D304

24.7400 (1160,1395,1055)

AUTHOR:

Morgulis, N.D.

TITLE:

On the determination of gas pressure in the very low range by methods of electron adsorption

PERIODICAL:

Ukrayins'kyi fizychnyy zhurnal, v. 5, no. 2, 1960, 212-221

TEXT: Three electron-adsorption methods are described: 1) by reflection of slow electrons, 2) contact potential (direct and inverse) 3) auto-electronic emission. These methods are more advantageous than other ionization or adsorption methods. Thus, magnetron vacuum gauges permit measuring pressures as low as  $\sim 10^{-12}$  mm Hg, whereas the Alpert vacuum-gauge can be used only to  $1 \cdot 10^{-10}$  mm Hg; J. Hobson and P. Redhead (Ref. 1: Canad. Journ. of Physics, 36, 271, 1958). Adsorption properties of gases at low pressures are described. The aim of the adsorption methods consists in determining the rate of adsorption of a gas layer, i.e. the effective gas-pressure  $p'$ . Adsorption methods are especially desirable for devices used in the

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On the determination...

study of surface effects. The proposed methods are preferable to the glow method, since they eliminate a complex process of gas desorption, involved in that method. The simplifying assumptions underlying the proposed methods consist in averaging the parameters related to the composition of the residual gases and to the inhomogeneity of the adsorbent surface. On the method of slow-electron reflection, it was found that the reflection coefficient  $R$  is highly dependent on the surface concentration  $n$  of the adsorbed gas molecules; hence it was possible to use the time-dependence  $R = f(t)$  for determining the order of magnitude of effective pressure  $p'$  of the residual gases. The relation

$$\left(\frac{dR}{dt}\right)_0 = \left(\frac{dR}{dn} \cdot \frac{dn}{dt}\right)_0 = C_2 p' \quad (6)$$

is obtained. The experimental lamp used had a set-up for measuring  $R$ , and Alpert vacuum gauge, etc. On the method of contact potential, in the adsorption of residual gases on metal surfaces, the work-function  $\varphi$  of electrons may considerably vary, hence the contact potential  $v_k = \Delta\varphi$ . Therefore, the time dependence  $v_k = f(t)$  can

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be used for estimating the gas pressure:

$$v_k = 4\pi\mu n \quad \text{and} \quad \left(\frac{dv_k}{dt}\right)_0 = 4\pi\mu_0 \left(\frac{dn}{dt}\right)_0 = C_3 p \quad (7)$$

where  $\mu$  is the dipole moment of the adsorbed molecule. For the coefficient  $C_3$  the empirical value of  $\approx 10^{-5} \text{ sec}^{-1} \text{ mm}^{-1}$  is obtained. The method just outlined is a direct one. The inverse contact-potential method consists in determining the time dependence  $I_k = f(t)$  of an electron current, related to the gas pressure. On the method of auto-electronic emission, the pressure can be indicated by the rate of emission on a screen, or by the change in character of emission, but especially by the relationship  $I_E = f(t)$  in the adsorption process. The formulas for the current  $I_E$  are analogous to those used above. A special experimental lamp was used for verifying the method. It is noted that photo-electronic emission can also be used in this method. These methods are useful as complementary ones to the ionization methods. At present, the most convenient and simple are the contact-potential methods, whereas the auto-electronic emission method holds out prospects for the future. All the

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described methods are still in need of greater accuracy. There are 8 figures, 1 table and 12 references: 3 Soviet-bloc and 9 non-Soviet-bloc. The 4 most recent references to the English-language publications read as follows: J. Hobson, P. Redhead, Canad. Journ. of Physics, 36, 271, 1958; J. Eisinger, Journ. Chem. Phys., 30, 412, 1959; T. Hickmott, F. Hudda, Journ. Chem. Phys., 28, 506, 1958; T. Hickmott, Bull. Am. Phys. Soc., 4, 139, 1959.

ASSOCIATION: Instytut fizyki AN USSR (Physics Institute, AS Ukr-SSR)

SUBMITTED: September 30, 1959

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20428

S/109/60/005/012/026/035  
E192/E582

26.2531

AUTHOR: Morgulis, N. D.

TITLE: On the Role Played by the Contact Potential Difference  
in Thermionic Energy Conversion

PERIODICAL: Radiotekhnika i elektronika, 1960, Vol. 5, No.12,  
pp. 2052-2053

TEXT: In connection with the paper by V. Grodko and others appearing on p.2046 of this journal, the author wishes to state the following. The problem discussed by V. Grodko et al. is not new nor are the results obtained by them; for example, in a paper published by the author with his collaborators (Ref.1) the problem of the influence of the contact potential difference  $\varphi_K - \varphi_A = U_K$  on the output parameters of a thermionic energy converter was also investigated and it was shown that with decreasing  $\varphi_K$  (such that  $\varphi_K \geq \varphi_A$  at a constant cathode temperature) the following effects could be observed: 1) the electro-motive force of the converter was constant, 2) the optimum output voltage was reduced, 3) the specific power was increased and 4) a maximum energy efficiency could be observed. In fact, the quality of a converter is determined by the energy efficiency and not by its electron  
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On the Role Played by the Contact Potential Difference in  
Thermionic Energy Conversion

efficiency. As regards the latter efficiency, it is shown by B. Grodtko et al. that these can be as large as unity, i.e. considerably higher than the Carnot efficiency. It is further pointed out that at present and in the near future it will be necessary to base all the thermionic energy converters on systems with a finite potential difference (i.e.  $\phi_1 > \phi_2$ ); secondly, this case gives a very high energy efficiency (K. Hefnquist, M. Kanefsky, F. Norman, Ref.2). On the other hand, the problem of a low temperature energy conversion based on the use of small  $\phi_K$  is also worth investigating, as was pointed out in an earlier work (Ref.1). There are 4 references: 3 Soviet and 1 non-Soviet.

ASSOCIATION: Kiyevskiy gosudarstvennyy universitet im. T. G. Shevchenko (Kiyev State University imeni T. G. Shevchenko)

SUBMITTED: June 20, 1960

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62284

S/089/60/009/01/08/011  
B014/B070

9.3/20  
AUTHORS:

Morgulis, N. D., Korchevoy, Yu. P.

TITLE:

Thermoelectron Conversion of Thermal  
Energy Using Thorium Carbide Into Electrical

PERIODICAL:

Atomnaya energiya, 1960, Vol. 9, No. 1, pp. 49-51

TEXT: In continuation of the published works of Ref. 1, first of all a cathode material (one-component type) was sought, which would have marked emissivity even at  $T \approx 2000^\circ\text{K}$ . A diode filled with cesium vapor was employed, whose cathode was a tungsten band in the center of which was applied a thin film of  $\text{ThC}_2$ . A tantalum anode with a shielding was placed at a distance of about 1.5 mm from the cathode. The temperature of the cathode was measured by means of an optical micropyrometer. The measuring flask into which a drop of cesium was put, was placed in a thermostat. Thus, the pressure of the cesium vapor could be determined from the constant temperature of the flask, which could be exactly measured. The interesting parameters of  $\text{ThC}_2$  were determined by methods

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of ion and electron emission. For the temperature range 1900-2100°K and at a cesium temperature of 250°C, a specific cathode power  $\omega = 12 \pm 4$  w/cm<sup>2</sup> and an efficiency of thermoelectric conversion  $\eta = 12 \pm 3$  % was found. These results are supplemented by taking the current-voltage curves (Fig. 4) for an inner and an outer circuit. In the first case, the saturation region between  $V_R = -0.2$  and  $-1.6$  v is hardly marked for reasons not known. In the second case, it is remarkable that the region of arc discharge is missing. Professor G. V. Samsonov from the Institut metallokeramiki i spetsasplavov AN USSR (Institute of Powder Metallurgy and Special Alloys of the AS UkrSSR) prepared the thorium carbide. There are 4 figures, 1 table, and 3 references: 2 American and 1 Soviet.

SUBMITTED: February 6, 1960

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1720660615, A. P.

S. 440  
S. 450

62159  
S/048/60/024/06/04/017  
B019/B067

AUTHORS: Morgulis, N. D., Naumovets, A. G.

TITLE: Formation Kinetics and Some Properties of Oxygen Films  
Adsorbed on Tungsten ✓

PERIODICAL: Izvestiya Akademii nauk SSSR. Seriya fizicheskaya,  
1960, Vol. 24, No. 6, pp. 647- 656

TEXT: This is the reproduction of a lecture delivered at the 9th All-Union Conference on Cathode Electronics from October 21 to 28, 1959 in Moscow. This paper is devoted to calculation problems of oxygen adsorption on tungsten. In the introduction, these processes are discussed in general, and formula (1) for the rate of formation of a film adsorbed on the surface is given. Furthermore, the test tube shown in Fig. 1 is discussed with which the surface potential of a tungsten band contained in the tube can be measured. This tube is equipped with an Al'pert manometer by means of which the pressure jumps in the ionization can be measured. In this part of the paper, B. A. Chuykov, Ya. M. Kucherov, V. K. Medvedev, and Yu. S. Vedula are mentioned. The second part of the paper deals with

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the adsorption kinetics of oxygen films on tungsten. In Fig. 3 the dependence of the contact potential on the period of adsorption with different oxygen pressures is graphically represented. From this diagram the authors obtain the coefficient for the oxygen condensation ( $\gamma = 0.05$ ) by formula (6), and they point to its low value compared with other results. In the discussion of this result it is pointed out that this problem has not yet been theoretically dealt with, and in conclusion it is stated that on the basis of the results obtained here it is difficult to determine the coefficient of oxygen condensation. In the comprehensive discussion of the properties of the adsorbed oxygen the dependence of the contact potential on the period of adsorption and the temperature (Figs. 6, 7), the dependence of the jumps on the temperature for pure CO and pure  $O_2$ , and the dependence of the jumps on the adsorption period with various pressures (Fig. 11) are dealt with. The existence of a second adsorption phase of  $O_2$  which could not be proved here is

discussed. Furthermore, the effect is pointed out in which apparently the film of CO molecules is replaced by  $O_2$  molecules. The authors thank Iu. G. Ptushinskiy for assistance given in the performance of the work.

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Formation Kinetics and Some Properties of Oxygen  
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There are 11 figures and 12 references: 7 Soviet, 1 British, 3 American,  
and 1 German.

ASSOCIATION: Institut fiziki Akademii nauk USSR  
(Physics Institute of the Academy of Sciences, UkrSSR)

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4

24.2700  
9.3120

66011

AUTHOR: Morgulis, N. D.

S/053/60/070/04/004/011

B006/B011

TITLE: Conversion of Heat Energy Into Electric Energy by Means of Thermo-  
electronic Emission

PERIODICAL: Uspekhi fizicheskikh nauk, 1960, Vol 70, Nr 4, pp 679-692 (USSR)

TEXT: The present article offers a chronological survey of experiments, methods, and possibilities of converting heat energy directly into electric energy. Experiments were begun in 1949 by working with the thermoelectronic emission from pure tungsten in cesium vapors; the efficiencies attained were very low. Today, there are already small laboratory instruments attaining an  $\eta \sim 15\%$  and (per cathode surface unit) a specific power of  $\omega \sim 30 \text{ w/cm}^2$ . An important contribution to these problems has been made by A. F. Ioffe who suggested the "vacuum thermocouples" working on a semiconductor basis. The laboratory instruments used today may be divided into two classes: vacuum instruments, and gas- or vapor-filled instruments. The first part of the present article deals with investigations and their results in the first stage during the years 1949 to 1957. The second part is devoted to the latest achievements in the field of thermoelectronic converters (1958-1959). The results given by the papers mentioned in references 9.28 are discussed. Investigations in this field were intensified in 1958. a great number of laboratory instruments for direct energy conversion was developed, and the possibilities of

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cathode heating by means of nuclear energy were investigated. Again, cesium vapors were made use of, that had stood their test in the production of contact potential differences (increase of efficiency) and in the neutralization of electron space charge by thermal ions. A converter with a high-temperature W cathode in Cs vapor (Ref 9), that was investigated in the range of 2350-2910°K, is discussed next. In this case, good agreement was found with theory in that  $\eta \approx 10\%$  at 2900°K. As may be seen from the table,  $\eta$  and  $\omega$  rise exponentially with the cathode temperature (cf. also Fig 9). Besides W cathodes also such of Re and Ta (Refs 13, 14) were investigated. At 2900°K, such instruments attained only  $\eta \approx 5\%$ . Since a low-voltage discharge occurred between the electrodes, the instrument was termed "plasma thermocouple". A further temperature increase of the cathode ( $\approx 3000^\circ\text{K}$ ) brought about a rise of  $\eta$  to  $\approx 15\%$  at  $\omega \approx 30 \text{ w/cm}^2$ . As may be seen from figure 11, efficiency drops sharply if there occurs a discharge between the electrodes. In order to keep the space charge as low as possible in the case of vacuum devices, experiments were undertaken with very strongly approached electrodes (up to  $10\mu$ ) (Ref 16). The authors worked with two low-temperature L cathodes; figure 12 shows a comparison between theoretical and experimental results. It is assumed that with about 30 such cathodes it is possible to attain a power of 0.5-1.0 kw at  $\eta \approx 0-15\%$ . Further investigations of low-temperature cathodes in Cs atmosphere followed. The production

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of positive Cs ions by local thermal ionization is described (Ref 18). Working with cathode-adsorbed  $Cs^{20}$  seems to be promising. In reference 21, calculations of hypothetical thermoelements were made, that were expected to render possible an  $\eta$  of 25-30% at 1100°C, and to attain a total efficiency of 50-60% together with a steam turbine plant. Further low-temperature cathode converters are mentioned (Refs 22,23) along with a theoretical investigation (Ref 25). Finally, a few suggestions made by Western authors concerning the direct conversion of nuclear energy into electric energy are discussed. The efficiencies of these instruments are between 5 and 10%; only in the case of a temperature difference between cathode and anode amounting to 2000° an  $\eta \sim 25\%$  would be possible. There are 18 figures, 1 table, and 28 references, 14 of which are Soviet.

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